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TO: North Coast Watershed Assessment Program Management Team

The University of California Center for Forestry has been asked to coordinate a scientific peer review of the Resources Agency's North Coast Watershed Assessment Program's (NCWAP) "Watershed Assessment Methods Manual." To carry this out, the Center arranged for a group of scientists to review the overall manual and provide a brief synopsis of their overall evaluation of the scientific merit of the work, with special reference to strengths and weaknesses of the approach proposed. All comments were provided directly to me. I will provide a very general synopsis of the overall comments received below. In addition, there is attached to this cover letter, a copy of the individual comments, including actual notes by various reviewers within the body of the manual itself.

Scientific peer review is a typical procedure followed in the evaluation of scientific journal articles to ensure that inferences and conclusions of a scientific work are logical and clear, and that appropriate analytical procedures are followed that support these. Peer reviewers are sometimes kept anonymous by the review coordinator or editor to minimize personal bias. Because of the broad, interdisciplinary nature of the NCWAP Methods Manual, I have chosen to let the Management Team see the comments of the various reviewers to give their context. Part of the culture of scientific peer review is that they often emphasize the weaknesses or shortcomings of the work, while not adequately complementing the positives. However, although the comments often appear hard hitting, they are always intended to be constructive. Topics not addressed by a reviewer are usually considered to be acceptable. The goal is to ensure that the work is defensible based on the body of science.

There were eight different reviewers of the draft manual. These are:

- Gerald E. Weber, Geological Consultant, Santa Cruz, Certified Engineering Geologist (CEG)
- Matt O'Connor, President, O'Connor Environmental, Inc., PhD, Registered Geologist (RG)
- George Ice, Nat. Council for Air and Stream Improvement, PhD, Professional Hydrologist (PH), Registered Professional Forester (RPF), Certified Forester (CF)
- G. Mathias Kondolf, Associate Professor of Env. Planning and Geography, UC Berkeley, PhD
- Frank Ligon, Stillwater Sciences, Berkeley
- Thomas E. Lisle, USDA Forest Service Pacific Southwest Research Station, Arcata, PhD
- Leslie M. Reid, USDA Forest Service Pacific Southwest Research Station, Arcata, PhD
- Robert R. Ziemer, USDA Forest Service Pacific Southwest Research Station, Arcata, PhD

Some of the general items brought forward by the reviewers are described below.

In general, the concept of NCWAP and a state-sponsored watershed assessment was applauded. Most of the reviewers made comments that complemented the interdisciplinary, interdepartmental approach to watershed assessment. The general approach was felt to be a great improvement over anything attempted in state in the past. The reviewers felt that NCWAP was an important and ambitious program for the state. Most reviewers felt that the manual was well organized, clear, and well written. There are many wording and grammatical suggestions that are found in the attached annotated copies by the various reviewers.

At least two of the reviewers had some problems with the reference to this document as a manual. They pointed out that it is more of a general policy overview or blueprint of the NCWAP program. It really doesn't lay out a procedure that can be applied from watershed to watershed, but gives a broad strategic overview of the general approach. One reviewer suggested it might be better to start with a prototype assessment for the first area, and then to conduct a peer review of actual approach used, as a guide other assessments. Another suggested that the manual was lacking by not having a concrete example of application of the methods described.

Both Ice and O'Connor had good suggestions for improving the description of other watershed assessment methods used in the West. Their reviews provide some corrections for the descriptions of existing northwestern watershed assessment programs that should be incorporated into revisions.

In general, the reviewers felt that the draft manual doesn't spell out in enough detail how individual scoping will occur in specific watersheds. I know that I heard this discussed in several of the public meetings in some detail. The manual needs more description about how this will be addressed. Several reviewers emphasized that this initial scoping is perhaps the most important starting point of the watershed assessment. They also pointed out that preliminary initial scoping efforts should bring in the land history analysis, as this would form the basis for other modules.

There were several comments that the draft manual needs a clearer statement of how the critical questions will be answered through the formulation of hypotheses that will be tested through the development of data collection procedures. There is a very good suggestions about how the entire NCWAP process could utilize a formal adaptive management approach (see Kondolf suggestions especially).

Several reviewers pointed out that the manual really only addresses a limited number of the beneficial uses of a watershed. Although I understand that that the scope of NCWAP is largely governed by the legislation that established the program, there should be more of an attempt to evaluate where additional questions about watersheds might be addressed as well (see especially Lisle, Reid, Ziemer comments and their Table 2). Some reviewers felt that many of the controversies about watershed impacts, and the need for planning and assessment, will be inadequately addressed by limiting the scope of NCWAP. Revisions should carefully consider the point raised by reviewers about why certain important watershed questions are not included.

There were a number of concerns raised about the data itself. Several reviews pointed out that ideally, the process followed should establish baseline data that has sufficient statistical power to answer the critical questions the data is being collected to address. Data development should lay the framework to serve as part of a longer term monitoring program. It may be necessary in revisions of the report to obtain statistical advice on the design of data collection so it can be used to evaluate changes. Reviewers felt that the manual needs to have a discussion of monitoring. It was pointed out that the program can't answer questions by just collecting data. There were also concerns expressed about using data from various sources and time periods. A formal appraisal of how the data will be collected, and limits to its use should be spelled out. The watershed assessment should drive the data development – not the data development driving the watershed assessment. This needs to be an ongoing process that doesn't stop with the final report.

The discussion of the Limiting Factors Analysis (LFA) raised the most comments by reviewers. Most felt this section needs to be revised and clarified. The recent EMDS training session for NCWAP staff should make this easier. Many of the reviewers were concerned about the availability and quality of data, the validity of proposed models, and the need to consider cumulative impacts. The analysis needs to consider limiting factors relative to natural conditions. There was concern expressed that without this evaluation of natural range of variability of watershed factors, that alternations of natural conditions may have unintended consequences for species not included in the NCWAP review, but nonetheless important. Much more description is needed on how the desired conditions or reference conditions will be met. A stronger link is needed between in-stream conditions and current land use activities. The process also needs to consider what is physically achievable in a given stream reach or planning watershed.

Specific to the EMDS Expert System, there were a number of concerns raised about its use. What provisions are being made to ensure that the correct factors are being chosen? What is the feedback loop to validate and modify the model? Does the data to support the hypothesized relationships exist, or will it be collected? The example graphs illustrating the use of EMDS in the manual need to document the source of the relationships presented. There are concerns about inferences drawn from poorly documented relationships. There is also concern that inappropriate use of the model will result in a "Garbage In Garbage Out" situation. The hypothesized model needs to be tested in a location where there is fish population data to demonstrate the utility of this approach.

Reviewers raised concerns about how sediment transport will be evaluated in the watershed assessment process. The landslide mapping data doesn't appear to tie-in with the critical questions posed on erosion processes and stream health. The description in the manual does not make this link. There was a lack of specificity of the surface erosion model to be utilized. The large number of landslide maps to be generated was felt to potentially provide much useful information on sediment transfer process, however, this would involve additional spatial analysis and risk rating approaches not described, rather than the process being limited to just the maps. Also, NCWAP needs an evaluation of other sources of sediment transport (roads, land use change, etc.). The process could also could utilize modeling approaches such as SHALSTAB, and compare the model results with actual landslide data. The erosion module of the manual needs additional work to address some of the questions of sediment transport.

Concerns were raised about the stream gauge stations used in NCWAP. To address the critical questions posed, reviewers felt it really is necessary to evaluate the potential for establishing headwater gauges. Reviewers were also concerned that even though there would be a large investment in gauges and collection of historical time series of flow data, the report indicates that only mean, maximum, and minimum flow data will be used. The analysis should also consider evaluation of flood frequency, flow duration, seasonal hydrograph patterns, inter-annual variations in flow, and possibly other information as well.

The direction for synthesis of results for the entire watershed assessment between the diverse disciplines and state departments is not clearly spelled out. The reviewers commented that there was not a clear direction on how the synthesis will occur as part of NCWAP. There was concern that the management team lacked the necessary authority to override individual departmental priorities. This perceived lack of authority may create problems in the timely submission of products, or uniform commitment by the various agencies. If this problem has been dealt with by administrative procedures, these should be spelled out in the final draft.

There are many additional good, constructive comments throughout the evaluations by the various individual reviewers. The management team should spend the time to review and consider all of these comments thoroughly. The final revision should consider how addressing these points can enhance the scientific merit of NCWAP.

I would like to personally commend the management team for development of the NCWAP Manual. It is impressive that you have been able to break downs bureaucratic barriers that have kept the various departments separate over many years, to produce an integrated, well-thought out strategy.

Please let me know if you have any questions about any of the points raised in these reviews.

Sincerely,

Richard B. Standiford
Associate Dean of Forestry
Center for Forestry

May 11, 2001

Dr. Richard B. Standiford
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Dear Dr. Standiford,

I read with great interest the draft North Coast Watershed Assessment Program (NCWAP) Methods Manual for Watershed Assessments. The manual is very well written, presents a logical progression of ideas, and is consistent with the approaches being developed in other part of the Western United States (Ice 2001). The Methods Manual might better be described as both a ***blueprint*** for development of the Watershed Assessment Manual and a draft Manual since the first two chapters include discussions about how the manual is being developed that will need to be pulled out of the final manual. For example, the discussion about the scientific peer review panel (of which this letter is a part) will need to be dropped from the final manual or modified as a statement supporting the defensibility of the method. The use of a limiting factors analysis is appropriate for the key questions dealing with salmonid population response, although you will find some cautionary notes below. There is "fuzziness" in the description of the methods to be used, some of which is intended to allow for creative and flexible application of the watershed assessment. The greatest improvements in the manual could be achieved with a few concrete examples of how this method could be applied. One suggestion might be to conduct a partial watershed assessment **before** publishing the manual and then incorporating application examples into the manual.

On page 11 there is a discussion about the 305(b) and 303(d) reports that states are required to develop. You may need to follow up on this section carefully as it is in flux. The final proposed TMDL rules will not go into effect until later this year, unless Congress makes some changes. If adopted unchanged, these rules would allow states to submit their 303(d) lists every 4 years beginning in 2002.

The description of current watershed assessment and analysis methods is appropriate and just about the right length for this document. It might be useful to focus on the strengths of each so that it can key readers into where they can mine good ideas. For example, the Oregon Watershed Assessment Manual is especially useful in providing guidance on where to obtain existing information. I have some suggested additions to the description of the Washington approach which have been placed directly in the document. These suggested changes point out that it is voluntary process and that there are benefits for those who have land in watersheds where an analysis has been conducted.

The figures seem uniformly well done. However, figure 3 didn't display disciplines (title and nature of discussion) but rather watershed functions. My suggestion is to add disciplines to the watershed functions balloons so that the inter-disciplinary nature of the process is explicitly displayed. Because this is both an inter-agency as well as

interdisciplinary process, the agency responsible for watershed function assessments could also be displayed.

The steps discussed on page 17 are consistent with those used in other watershed assessment procedures and the recent EPA guidance document (EPA 2000).

The limiting factor analysis for salmon involves a series of mapping exercises that compare watershed conditions with a range of desirable conditions developed from a formal knowledge base. This is an appropriate step. Nevertheless I am cautious about the results because of the difficulty in actually identifying desirable conditions and establishing limiting factors. We have a history of too often setting "desirable conditions" for fish using human preferences rather than fish needs. The much be-labored case of wood in streams and stream clean-outs (for neat, free flowing streams) is an example. But there are so many other emerging examples that I worry that we may develop a technologically sophisticated assessment tool that is assessing the wrong things. A striking example is the recent International Conference on Restoring Nutrients to Salmonid Ecosystems (http://www.gpafs.org/confnutr). Loss of ocean-derived nutrients (from returning salmon) may result in clear, clean and unproductive streams. I remember being told of Stinky Creek which got named for the odor of rotting salmon carcasses. Today Stinky Creek might have lower nutrient level and clearer, sweeter smelling water, but less returning salmon.

There are a couple of possible approaches that could be used to minimize the problem of inappropriate metrics. First, the stream classification system will need to be used as part of the setting of desired conditions. Low gradient, wide, unconfined streams can't be expected to provide the same habitat as steep headwater reaches. Also, the overall assessment path is designed to be iterative with two stages of analysis. This design is helpful and should lead to adaptive management. So if high nutrient-level streams are identified as outside the range of "desirable" conditions but these reaches display fish populations that are relatively health then the "suitable conditions" metrics may need to be revisited.

One other concern is that limiting factor analysis and suitable condition inventories alone are not useful if what is physically achievable is not considered. EPA Region X is struggling with the development of guidance for states to develop temperature criteria. Three approaches are being considered. **The species and life stage approach** uses the literature to set appropriate temperatures for salmon for different life stages. A maximum is selected for each life stage to avoid harmful effects and rivers and streams are mapped to show where and when salmon are present for different life stages. (This is essentially what the NCWAP is proposing). However, there has been criticism of this approach because it doesn't consider what is physically achievable. So states end up setting water quality standards that can not be achieved, especially for exposed, mainstem reaches. **The thermal potential approach** uses models to define the temperature patterns that would have "naturally" occurred, assuming that salmon are adapted to pre-European influence conditions. This will involve modeling of watershed temperature patterns **The distributed threshold approach** focuses on maintaining and enhancing high quality

thermal habitat for salmon and identifying necessary amounts and spatial distributions of cold water habitat. More information about these approaches can be found at http://www.epa.gov/r10earth/water.htm. Some combination of these approaches is probably appropriate, but is yet to be determined.

There was some question about using 10 meter data in the GIS assessments. Robison et al. (1999) provides a comparison of the quality of results for slope using different scale GIS information.

There is an improving body of information about riparian microclimate. I am sending a copy of the microclimate section from an Oregon Forest Industries (OFIC) sponsored report. Also, I am including a copy of Danehy and Kirpes (2000). Finally, Sam Chan (Olson et al. 2000) and Sherri Johnson from the USDA Forest Service Pacific Northwest Research Laboratory just made a presentation to the Washington Cooperative Monitoring Evaluation and Research (CMER) workshop on microclimate and they should be contacted.

Interpreting channel changes deserves some more discussion. My notes in the document point out that channel downcutting can occur in one segment while aggradation is occurring simultaneously in another reach (Burke and Nutter 1995). Benda (1999) provides an insightful approach to understanding the potential differences in patterns of channel response for different reach types.

I looked at the definitions and found them clear and concise.

In summary, if I were reviewing this manual for a publication I would commend it for the clear, well-written style and the overall content. I would ask for minor revisions, particularly in providing some concrete examples of how the method will be applied and the information synthesized into an assessment.

I look forward to progress on this project and hope that I can contribute to that effort.

Yours truly,

George Ice

Dr. George Ice, P.H., C.F.

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Comments on
"Draft Watershed Assessment Methods Manual"
(undated, anonymous)

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1 June 2001

General Comments

I present general comments below on the document and its proposed approach, followed by some comments specific topics and specific sections of the document.

Overall

I applaud the effort to embark on this watershed assessment program, especially in its explicit attempt to assess cumulative effects on a basin scale. The philosophy expressed in this document is a vast improvement over the crude and easily manipulated methods based on threshold of calculated "equivalent roaded area", often in direct contradiction to measurements of channel and habitat conditions in the field. I am particularly happy to see historical analysis incorporated as a basis for basin planning, a range of different approaches (including macroinvertebrate sampling) used for water quality monitoring, and a holistic basin-level understanding underlying this document.

Purpose of the "Manual"

Although the document is entitled a "manual", it seems to be more of a policy document and proposal for data gathering and analysis. Unlike the manuals with which I am familiar, it does not provide explicit guidance to those seeking to undertake certain analyses. (One could not hand this to an interested party and say, "now go do a watershed assessment.") Some specific methods are included, but mostly they are lacking in the document. From the little I understand of the program and process that produced it, I suspect that such a detailed document would be premature anyway – a proposal for approaching the (daunting) task is more appropriate at this stage. However, it is difficult to critique and review a document when its purpose is unclear or seems to be at odds with its title.

Magnitude of the Task and Commensurate Resource Commitment

The task set out is enormous: to collect, compile, and analyse original and previously collected data to assess current watershed conditions, historical changes, identify factors limiting salmonid reproductive success, and thereby guide future restoration and conservation actions in the region. For example, the questions listed on p. 50 are all very good questions, and they would probably provide challenges enough for more than one masters thesis in each river basin. How will these be addressed in every basin designated for assessment? Frankly, I doubt there is much in the way of really useful, consistent, high-quality data already collected (and waiting to be pulled into a master data base) suitable to answer the geomorphic questions posed. I can well imagine staff from DFG, DWR, DMG, and the regional boards tackling these questions (with sufficient resources and the benefit of good outside review), but how much staff effort has actually been committed to this effort? The magnitude of just tracking down the available historical aerial photography is acknowledged on p.67, but many of the other envisioned activities are described without explicit acknowledgement of the magnitude of the tasks or details or how they can be implemented and with what staff and resources.

I think the effort proposed here is important, should be undertaken, and will yield benefits even beyond the immediate goals. However, I am concerned that the document may promise more for more basins than can really be delivered in seven years. The lack of explicit estimates of staff and resource needs for various tasks, and of specific commitments from various agencies, raises the question of whether this proposal is more like a South American constitution: lofty ideals and good intentions, but little

correspondence with actual implementation. I'm not saying the project will not succeed, but given that the 'manual' seems to be really more of a proposed program of data collection and analysis, I think it would be more convincing if the means to that end were explicitly indicated.

Towards an Adaptive Management Approach

The process model implicitly underlying the program presented here is a traditional, linear science-based planning model: first we collect and compile information, synthesize it, then present it to decision makers to inform their decisions. However, even with adequate resources to undertake the various study components envisioned for a given watershed, at the end of a study there will probably remain considerable uncertainly about some critical linkages, and thus what management actions can and should be taken to improve conditions for salmonids. This implies that a watershed assessment program should be undertaken under an adaptive management framework, with a long-term commitment to monitoring, with actions designed and undertaken as *experiments* to test conceptual models of linkages among processes, habitats, and salmonid populations, and with a feedback process whereby results of pilot actions can inform revised, more accurate, conceptual models, which then are the basis for more effective restoration actions in the future. Under the adaptive management approach, the conceptual models underlying restoration strategies would be made explicit, and to the extent possible, expressed as testable hypotheses. The hypotheses can be tested by targeted research and by pilot restoration projects designed to yield critical information about the data gaps.

The point is simply that these underlying relations are complicated and cannot necessarily be sorted out from the data that happen to exist already. The document acknowledges that data gaps exist and will need to be filled. However, with the exception of some standard data needs (such as stream gauging), the real data gaps may not become apparent until conceptual models are developed. Once the key data gaps are identified from the conceptual models, then they can be addressed by research and informed by the results of pilot restoration actions. The amount of possibly-relevant data that could be collected about a given watershed is virtually infinite, so the 'data gaps' to be filled must be selected with care, lest we find ourselves awash with 'data' but unable to float defensible hypotheses.

Thus, the document's implied linear approach of data collection, compilation, and synthesis may not work out given the uncertainties likely to remain. Under an adaptive management approach, the initial study period (ca. two years per basin) would not 'finish' a watershed assessment, but rather would be a first phase of an ongoing adaptive management of the basin. This first phase would yield alternative conceptual models of physical and ecological processes in the basin, identify key data gaps and uncertainties, and proposed targeted research and pilot projects to test conceptual models and fill key data gaps.

Using Available Data

It certainly makes sense to use the data already available, but having compiled data from various sources on different topics in the past, I would caution of the challenges and difficulties of doing this. The data available differ among studies and sites in method, spatial scale, time period of measurement, hydrologic conditions, quality control, purposes for which the data were collected, etc. For example, a PhD student at Berkeley attempted to use DFG habitat typing data collected for his watershed in an analysis linking watershed characteristics with salmonid habitat quality (essentially the same sorts of questions being posed here), but as he worked with the habitat typing data more deeply, he found that for various reasons it was difficult to use them to answer some of his questions. At some point, he was faced with the choice of trying to make the DFG data "fit" somehow and using them for a much restricted purpose, or simply starting over with a systematic, geomorphically-stratified random sampling scheme. After investing so much effort in working with the habitat typing data, he was, of course, reluctant to abandon the attempt. In his case, as a PhD student, he can devote the time to working with the data, field replicating them, etc. But how can we insure that the agency staff assigned to this project have enough time, training, and motivation to insure the quality of existing data used, and the real suitability for the purpose at hand? Will they be free to declare that the data are not suitable for certain questions being asked and that new data need to be collected?

It may be easy to compile the available data from various sources, but putting them together in a meaningful way, especially using them to draw inferences of cause and effect (as proposed in this document), may not be as easy as it first seems. Unless the data collection program was designed around the questions to be answered, there is always a danger that the data will not answer the right questions. It seems obvious to use the available data, but there must be a realistic, objective, scientifically-based appraisal of how these data can be used.

Inter-Agency Coordination and Thinking 'Outside the Box'

Under the scheme proposed here, different agencies will collect different sets of data, and a management team will pull it all together. Again, this implies a linear approach of data collection, compilation, and synthesis, with the disadvantages described above. Moreover, it assumes a level of commitment from agencies (discussed above) and coordination among them that may be difficult to achieve. Managing so many different professionals, in so many different agencies, reporting to so many different bosses, it may be difficult to get all the various data components assembled at the same time. I can envision that one key set of data could remain missing because the responsible agency had a crisis that trumped the watershed assessment program (in terms of within-agency priorities) and diverted staff. What sort of authority will the management team have? What incentives will it have to encourage timely submission of information from the participating agencies?

Once the data components are assembled, the hard part begins. How to avoid the assessment from becoming a boilerp late exercise, reciting a litany of geology (erodible rocks, landslides, inferred increased sediment yield), hydrology (rainfall-runoff, inferred changes in hydrologic response), land use (timber harvest history, gravel mining, encroaching suburbs), water quality (T, DO, TSS), habitat (x number pools per mile, pool/riffle ratios, riparian cover), and biology (decline in salmonid populations), followed by the standard prescriptions: make more pools (stick in root wads), control erosion in the basin (make loggers use BMPs *[themselves untested!]*), etc.? How can the management team effectively draw out the insights of professionals in the field, make sense of the mass of data (of varying and often uncertain quality), step back and think 'outside the box' to understand the key processes, how they have been affected by humans, and how to preserve what still works and restore natural processes elsewhere? Even with academics, it is difficult to achieve effective symmetries among scientists of different disciplines due to differences in training, priorities, research style, etc. If the watershed assessment is really going to yield insights, there will need to be a chemistry among the participants. I certainly don't know much about how to achieve this, but people who do should be consulted to increase the likelihood that the management team will work effectively across disciplines.

Because the agencies are charged with specific aspects of the natural environment, they tend to work within a certain range of solutions. Nurturing the cross-disciplinary interactions required to see the watershed in a holistic, interdisciplinary framework will require strong leadership (and supporting authority) by the management team.

Expert System

The Manual devotes considerable space to discussing the expert system that will be used to store and analyze data: the software to be used, how the programs will be linked, etc. This discussion implicitly assumes that the important relationships are among the variables measured and input into the system, and that the critical functions can be expressed simply enough to be coded into the system. Neither of these assumptions is necessarily true. I understand the need to develop a data base and the desirability of linking the database with an analytical procedure to evaluate reaches and identify limiting factors. However, given data of questionable quality and the complexity of the physical and ecological systems to be modeled, this is more easily said than done. The old adage of GIGO (garbage in, garbage out) applied here.

The problems of data quality and suitability raised earlier apply here. To get the decision analysis system up and running on an ambitious schedule, there will be pressure to use some relationships among variables to make it work. An innocent-looking simplifying assumption made early on may turn out to make the results insensitive to important differences in some other input variable. Somehow the model needs to be thoroughly vetted by an independent group with the resources to really test how it performs and

responds to different ranges of input variables. A sensitivity analysis showing the range of model results as a function of ranges of input variables can highlight variables that are most influential in driving the system, at least according to the model.

The example given on p.33 displays the graph created by "scientists" showing "effect of the percentage of gravel in the streambed on coho spawning, egg incubation, and fry emergence suitability". This needs more explanation. First, what is meant by "% gravel in the streambed"? Does this refer to the amount of gravel in a bulk sample from a gravel riffle? Or the extent of the bed surface covered by gravel? The purpose and function of the "truth value" scale is unclear to me, even after reading the text twice. Perhaps this is the fault of my lack of familiarity with the method of Reeves cited here, but I suspect others reader of the document may likewise be lacking in background in this kind of procedure. It might be helpful to explain why the lines get farther apart from top to bottom and what exactly this means in terms of habitat. More importantly, if these lines (whatever they mean) reflect some sort of scientific consensus about suitable conditions, don't we need to know the evidence upon which this consensus was developed, the participants in the process, etc. to evaluate the consensus view? I am always concerned when I see the "scientists" are supposed to deliver expert opinions on x and y. "Four out of five doctors recommend brand x!" An appeal to authority alone is difficult to critique later, and for this watershed assessment process to work, it will need to be open to review and testing by others – not just for others to see how the dependent variables change with different input values, but also to see how the results change as some of the model assumptions are adjusted.

It is not clear to me how "results of the coho salmon assessment for the stream reach" can "support or refute the initial 'good condition' proposition" (p.34). Do the "scientists" come up with acceptable habitat limits and then reaches are measured to see if they fall within the acceptable bounds? Or is an attempt made to develop a relationship between gravel size and spawning use based on observations in each reach, which is then compared to the intitial model proposed by "scientists"? In the latter case, why bother with the judgment of the "scientists" at all - why not simply develop the relationship from the field data? It is not clear to me how the reach level "assessments" will generate useful data on the relation between gravel size and fish use anyway, as to do so would probably require labor-intensive sampling in different seasons. I would like to see some indication of the sampling technique (surficial pebble counts, bulk core samples, etc.), sample sizes, site selection (riffle crests, known spawning grounds), etc. Just to develop a relationship between gravel size and spawning use would be an enormous job, and the resulting data would be noisy. In sum, I cannot follow the judgments on gravel suitability shown here nor the proposed process to (apparently) use field assessments to somehow test the expert designation of suitable habitat.

Stream Gauging

The document notes that gauging programs by state and federal agencies have been cut, and that gauging data are sparse for the north coast. The document proposes to provide funding to keep existing but threatened gauges operating, and to establish new stream gauges on some streams, with a priority for downstream stations on basins lacking any gauging currently. However, the document does not give an indication of how many such gauges are likely to be established, where, and when. With gauging data, the longer the record, the more useful the data. If this program will last for seven years, I recommend that the gauge locations be identified and stations established right away, rather than waiting to establish the gauge on a stream until that stream comes up for its watershed assessment. (It's not clear from the document what sort of schedule is envisioned.) Moreover, if the idea of adaptive management for these watersheds is accepted, that implies that the gauges should be continued into the future, to provide critical information for assessing the effects of changed management practices.

While I agree with the importance of establishing downstream stations on basins that are now completely ungauged, I also recommend that gauges be established at some upstream sites to yield insights into the flow regimes of headwater streams. This is a particularly important need with respect to diversions of water from headwater streams, which have become more and more common with expansion of agriculture (notably vineyards) onto hillsides. There are no gauges (at least no standard USGS gauges with a long period of record) on these headwater reaches in the region, because historically there has been no water supply interest in streams such low (and commonly intermittent) flows. But with increasing demand

for diversions from headwater streams, the State Board is grappling with how to set minimum flow standards for these channels. Because the only flow records extant are from downstream reaches, the flows measured downstream have been extrapolated upstream on the basis of unit drainage area, probably yielding an unrealistic picture of the runoff from these small catchments. We should expect that these headwater streams would *not* behave as scaled down versions of the trunk streams below. Depending on the underlying geology and vegetative cover, they may be flashier, with higher unit flood runoff and lower (possibly intermittent) base flow, or vice versa. Understanding the runoff regime of headwater streams would be important for environmental management of the resource, not only for water diversions but also for understanding basin response to land use changes, etc.

The discussion of data collection on p.59 looks like it's taken from standard USGS procedures. Perhaps it might be most useful if these standard methods were incorporated by reference, and the document were simply to describe how the gauging proposed here would differ. (Again, without clarification on the purpose of this "manual", it is difficult to say what should and should not be included in this document.) It is unclear how USGS and DWR are expected to cooperate in the installation and operation of the gauges. The USGS has standard rates for installation and annual operation of gauges, so for this component of the overall program, it would be relatively easy to estimate annual costs as a function of the number of gauges to be established or taken over by the program. Thus, to the extent that this "manual" serves a proposal for a data collection program, it would be more convincing to have some real numbers for costs and some indication of how these would be met.

For historical streamflow data, the document proposed a surprisingly limited set of analyses. Only annual averages, minima and maxima are proposed to be assembled (p.60). It is ironic that after all the work proposed to establish new gauges and make their data available (with the document's detailed descriptions of "comma-delineated format", etc), these new gauges can yield relatively little useful information on their own due to their short periods of record. Yet where long-term gauges exist, only three variables (of limited utility) are proposed to be drawn from them. I would recommend that the long-term gauging records be thoroughly analyzed for flood frequency, flow duration, seasonal hydrograph patterns, inter-annual variations in various flow statistics, etc. Specific aspects of the hydrographs can be interrogated to yield useful information to inform ecological analyses. For example, the timing and steepness of the seasonal recession limb influences seedling establishment by woody riparian vegetation. We could expect that this recession rate has been altered in many catchments by human changes such as reduced infiltration due to vegetation changes, soil compaction, and resulting increased storm runoff.

The newly-established gauges will be most useful if they are used to extend and augment the records from existing, long-term gauges. For example, the new gauges can be used to extrapolate the hydrologic record from gauged streams to ungauged streams by comparing runoff patterns in the newly gauged basin with those at long running gauges in the region, and developing relations predicting flow at the newly-gauged sites as a function of flow at the long-gauged sites. Then runoff from past years can be simulated for the ungauged streams based on recorded values from the gauged streams. Newly established gauges in headwater reaches can be used to improve our understanding of runoff patterns in headwater channels as distinct from runoff in trunk streams. If consistent relations can be observed, we may be able to model runoff in headwater streams as a function of trunk stream flow (and geology, vegetation, land use, etc.).

Specific Comments

p. 27-31. Limiting factors analysis. I'm all for it, but how well can the computer program really identify the critical limiting factor? I'd like to build in a step in which the results of the model are tested against the independent assessments of biologists knowledgeable with the stream. A limiting factors analysis can be integrated into an adaptive management approach by stating its results in the form of testable hypotheses.

p.38. Not many details here on how cumulative effects will be addressed. The document acknowledges the need to include effects of non-timber activities and the challenge overall in trying to assess CWEs, but in effect "passes the buck" to the UC Center for Forestry. The document should be commended for avoiding the easy out of using the USFS ERA approach, and it's reasonable that this sticky problem is not

yet solved. However, it is not possible to critique the approach to CWEs (an important part of a watershed assessment) until the approach is specified.

p.39-44. Channel classification. The proposed method is plausible, as gradient, confinement, and sinuosity are all readily measured from maps and air photos (scale of photo and channel permitting). However, rather than simply accept this approach, I suggest it be viewed as a good first cut and tested to see how well the classes so defined match up with field conditions. The description of this method is not detailed, leaving many questions unanswered. As with many such procedures, the actual effectiveness will depend upon the team applying it.

Gradient: lumping all channels < 1% together implies the effort will be mostly in steeper headwater streams, as differences in channel form can be pronounced as one gets gentler, e.g. from 0.01 to 0.001 to 0.0001.

Confinement. Can't necessarily get at effective confinement (or lack thereof) from topo maps or DEM alone due to contour intervals and data resolution, and because the apparent "floodplain" may be cemented alluvium rather than erodible, active channel deposits.

Sinuosity. Always "subject to potential error", so need to explain why are automated procedures are more risky than manual methods. An alternative is the ratio of actual channel length to straight valley length, as this measure also captures side channels and other features of habitat importance.

p.44-47. I suggest that some mention be made of the importance of longitudinal connectivity of riparian corridors and that this be measured in the assessments. SNEP found that the most widespread and biggest break in riparian corridors in the Sierra Nevada were at reservoirs.

p. 47-48. Sediment effects on aquatic ecology depend largely on the timing of sediment introduction to the system. A given small amount of sediment might be no problem at high flow, just part of the natural sediment load of the river, but if introduced during base flow (when flows are inadequate to disperse and transport it downstream) the same amount of sediment could be a disaster by depositing in the bed.

p. 49, 51. Landslide susceptibility mapping (as done by Brabb and others at the USGS for the SF Bay area) is a big effort in itself. I recognize the value, only hope that the effort required is realistically understood.

p.50. Lots of good questions, not easy to answer.

p.53-55. Water quality impairment from accelerated watershed erosion will occur as transient events (mostly runoff from rainstorms), so sampling should probably be event-driven rather than at fixed intervals. Regarding the role of temperature, it's important to note the origin of the salmon, as California stocks may tolerate (indeed may thrive in) waters much warmer than preferred ranges published in the literature, which were based mostly on data from the Pacific Northwest.

p.63. I suggest that substrate composition be evaluated by species and life stage, e.g., salmon redd digging during spawning, incubtion, juvenile rearing, etc., as each life stage has different requirements for gravel.

REVIEW OF: WATERSHED ASSESSMENT METHODS MANUAL

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EXECUTIVE SUMMARY

NCWAP is an ambitious program with far-reaching and worthy goals. Initiation of the program is timely, and the program would have the potential to contribute valuable information and insight concerning a wide variety of potent environmental issues in northwest California if it were designed to be effective and efficient. Particular strengths of the draft assessment method include:

- The intention to produce an interdisciplinary assessment
- The intention to produce information relevant to a variety of applications
- The inclusion of a step to identify the issues relevant to each watershed
- The intention to provide answers to a broad array of potentially important questions identified in the draft manual as "critical questions"

Once the draft method is revised to assure that such goals can be achieved, the method is likely to provide a very useful assessment tool. Unfortunately, as currently constructed, the draft manual does not provide sufficient assurance that the program's objectives can be attained. Of particular concern are:

- The lack of direction for how "synthesis" is to be achieved
- The focus on a single overall key question about limiting factor analysis (LFA) for salmonids, which prevents effective evaluation of TMDL and cumulative impact issues
- The lack of a statistically valid plan for acquiring and using baseline information for future comparisons
- The inability of the draft methods to provide the information needed to answer many of the "critical questions"
- The lack of indication for how "desired conditions" or "reference conditions" will be defined
- The lack of direction and methods for evaluating the extent to which conditions have departed from those occurring naturally in each watershed
- The dependence on an LFA that does not appear to consider indirect and cumulative impacts, and that does not recognize the importance of the juxtaposition of diverse habitats
- Restriction of the assessment to the defined watershed, preventing consideration of how watershed conditions influence downstream beneficial uses and habitat conditions
- The lack of flexibility for determining what assessments are actually necessary and sufficient for each watershed
- Adoption of an assessment sequence that prevents effective utilization of necessary background information

- The appearance that the tasks—such as landslide mapping—were decided on first, and the overall assessment method was then designed to incorporate the desired tasks
- The frequent inclusion of qualifiers such as "if feasible," thereby leaving the reader with little indication of what is actually intended to be done.

These problems, if left unaddressed, will prevent the NCWAP method from achieving the stated overall objectives. Most of the problems, however, can be easily remedied through changes in organization and emphasis in the draft manual, or through modifications to the planned assessment sequence. Such changes might usefully include:

- Reorganization and expansion of the manual:
  - Include a description of information needs for each program objective and a description of how those needs will be met. Each program objective should have key and critical questions and a clearly expressed plan for answering those questions.
  - Reorganize the modular section by critical question rather than by mono-disciplinary task so that the logic-trail for answering each question can be established. If each question is "critical," there has to be a clearly documented strategy for answering it.
  - Include a detailed description of information needs for the limiting factor analysis, the assumptions upon which it is based, the specific methods to be used to carry it out for each watershed, and how the results will be used. The LFA method cannot be reviewed as presented because too little information is provided.
- Modification of the intended limiting factor analysis:
  - Explicitly consider indirect and cumulative effects.
  - Explicitly include comparisons to naturally occurring background conditions, and explicitly indicate how current and desired conditions differ from natural conditions.
  - Include assessment of how conditions influence habitats downstream of the watershed.
  - Demote the LFA from being the focus of the assessment to being one of the tools used to build the understanding of the watershed, and explicitly link the LFA to a complementary assessment of changes in conditions throughout the watershed in order to more effectively identify influences on current conditions and trends.
- Modification of the steps in the watershed assessment procedure:
  - Begin by scoping the issues relevant to each of the program objectives in and downstream of the specific watershed being assessed
  - Identify and compile readily accessible background information for each issue
    - information on the history and distribution of the beneficial uses
    - general information such as geology and topographic maps
    - identify key people with knowledge of particular issues
  - Identify the questions that must be answered to understand each issue
    - develop list of watershed-specific "critical questions"
    - develop plan for answering each
    - identify the specific information and level of precision needed to answer each
  - Proceed with assessment

- compile existing information identified as relevant and necessary
- carry out work to produce new information identified as relevant and necessary
- revise critical questions and assessment strategy as understanding develops

o Prepare report
- organize report by objectives and critical questions
- obtain comprehensive review
- revise report to correct deficiencies uncovered by review

Alternatively, if such changes are not desired, it would be necessary to revise the stated program objectives and critical questions to more closely reflect the capabilities of the program as currently designed.

REVIEW OF: WATERSHED ASSESSMENT METHODS MANUAL

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This review of the draft Watershed Assessment Methods Manual for the North Coast Watershed Assessment Program (NCWAP) is provided in response to a request by Dr. Richard Standiford on 4/18/01. The review first identifies the kinds of information that would be necessary to meet the objectives stated in the draft manual and compares the expected products of the draft assessment method with those information needs. Specific comments concerning aspects of the proposed method are then provided.

I. PROGRAM OBJECTIVES AND CONTEXT

The stated purpose of the watershed assessment process described in the 4/18/01 draft manual is to provide baseline data for evaluating the effectiveness of resource protection programs, to guide efforts to restore watersheds and protect salmonid habitat, and to help implement laws such as the California Forest Practice Act, the Clean Water Act, and the California Lake and Streambed Alteration Act. As described, the NCWAP is a major data collection and compilation exercise, with an analysis component directed toward defining limiting factors for anadromous salmonids. Data compiled during each assessment are expected eventually to support development and implementation of TMDLs, preparation of permit applications for THPs and other land-use plans, and design of restoration projects and monitoring plans.

A variety of watershed evaluation procedures have been developed elsewhere that share some of these goals. It is clear from existing evaluation procedures that certain kinds of information and approaches have been found to be particularly useful, but that the approach adopted for each procedure ultimately reflects the predilections and experience of those designing the method. In this case, the NCWAP approach is rather narrowly focused on providing information for an expert-system-based identification of watershed-specific limiting factors for salmonids listed under the Endangered Species Act.

The context in which the draft procedure has been developed is important because it indicates the relative importance of the various program objectives. The NCWAP program was initiated after several salmonid "evolutionarily significant units" (ESUs) were listed under the Endangered Species Act and after the National Marine Fisheries Service had indicated that existing state policies did not provide adequate protection for the listed species. Consequently, state agencies needed to demonstrate that efforts were being made to reduce the likelihood of extinction of those ESUs. Meanwhile, growing controversies over logging and development in north coast watersheds were leading to citizens' demands for broader assessments of impacts to beneficial uses of water. These concerns led to establishment of a rigorous schedule under which state and federal agencies are required to develop TMDLs for specified north coast watersheds. Timely development of TMDLs, however, is proving to be challenging.

Consequently, the immediate potential utility of the draft NCWAP method can be evaluated on the basis of the extent to which it will lead to protection of the listed salmonid species and facilitate development of TMDLs. Other objectives would appear to be of lesser immediate importance, but priorities may change as future challenges surface.

II. CAPABILITY OF THE DRAFT MANUAL TO MEET NCWAP OBJECTIVES

The ultimate test of a method is whether it can adequately meet its stated objectives. In this case, objectives have been presented at three levels: the overall objectives for the program (p.4, ph.3), the "key question" and the "critical questions for the entire NCWAP" (p. 19), and the "critical questions" presented for each of the assessment modules (pp. 41, 45, 49, 54, 58, 61, 66, 69, 71). The information needs required to meet each of these objectives are described below, and these information needs are then compared to the information likely to be produced by the draft procedure to determine whether the procedure is adequate for meeting its objectives.

Overall objective: provide baseline data for future comparisons

The first goal listed by the draft NCWAP manual is to "provide a baseline of data for evaluating the effectiveness of various resource protection programs over time" (p.4, ph.1). In essence, each assessment apparently is intended to provide baseline monitoring data. Requirements for successful attainment of this objective include those required of any monitoring program (Review Table 1).

Review Table 1. Requirements of effective monitoring programs

1. Each indicator must respond quickly enough to provide results in the time-frame desired
2. The cause-effect relationships that control the indicator response must be well-enough understood to ensure that results can be interpreted validly
3. Anticipated results must provide information relevant to program objectives
4. The signal must be statistically separable from the noise for the level of change expected to be operationally significant

Each of the variables selected for monitoring would need to be evaluated for the kinds and amounts of change expected, and measurements would need to be made in such a way that an operationally significant change, if it occurs, could be assured to be detectable over the time frame of interest. Any program intended to provide baseline data for later comparisons must have a statistically valid design if it is to be useful.

Unfortunately, the draft manual provides no description of what variables will be used for future comparisons, and there appears to be no actual plan or statistical design for the implied monitoring program. "Habitat typing" has been shown to be inadequate as a basis for monitoring, and it seems unlikely that the landslide mapping will be redone with any regularity. Information to be provided by the draft method will not prove useful for "future comparisons" without a coherent, statistically valid plan to put such information to use.

Overall objective: guide protection and restoration of salmonid habitat

Fisheries biologists do not know exactly what constitutes ideal habitat for each of the listed species. The level of knowledge is currently growing rapidly, and each year new aspects of the "ideal" habitat are added to the list. A limiting factor analysis carried out 20 years ago would not have considered woody debris as a positive influence; one carried out 15 years ago would have overlooked off-channel rearing habitat; one carried out 5 years ago would have ignored chronic turbidity; one carried out 3 years ago would not have considered carcass density. Five years from now, other factors will have been added to this list.

It is also clear that "ideal" habitat is not created by designing every point along the stream channel to have "ideal" habitat. Instead, a watershed is "ideal" for a particular salmonid species because of the juxtaposition of a variety of habitat types within the watershed. Some are "ideal" for the target species, while others are inimical to the target species, but are essential for maintaining or developing future "ideal" conditions in other habitats that are essential for the target species.

Species use a variety of strategies for coping with the distribution of conditions that existed naturally. These coping strategies generally rely on the existence of a variety of habitat types that are not necessarily directly used by the species or are directly used only for a short but critical portion of the year. For example, naturally hot water in the Trinity River did not prevent heavy use by salmonids because small, cold-water tributaries and deep pools provided periodic thermal refugia. Similarly, mud-bottomed intermittent floodplain tributaries become important refuge habitat for some species during floods, despite their "impaired" substrate and hydrology.

Finally, it is clear that any conservation strategy that is designed to provide perfect habitat for a single suite of species is not tenable. Other species of interest with different habitat needs inhabit the same channel systems; habitat alterations that benefit coho salmon may be detrimental to yellow-legged frogs or lamprey or spotted sandpipers. It is worrisome that the draft NCWAP manual indicates that some of the limiting factors of concern may be natural (p.25, ph.6). Limiting factor analysis is useful only insofar as it considers factors limiting salmonid populations *relative to* natural conditions. "Improving" natural

conditions for the benefit of a single species is not justifiable in a setting where other species—which are not a focus of the assessment—are also listed under the Endangered Species Act.

In short, a stream system designed to produce as many salmon as possible per unit area of channel would look disconcertingly like a fish hatchery, and we already know that this approach doesn't work.

Because of these considerations, science-based conservation strategies use naturally occurring background conditions as the standard of comparison against which the "desirability" of existing conditions is measured. The Aquatic Conservation Strategy of the Northwest Forest Plan, for example, focuses on reattainment of those naturally occurring process types and rates which maintained the hydrologic, sediment, and woody-debris conditions that sustained the distribution of species naturally present. Note that standard limiting factor analyses also generally use naturally occurring background conditions as the standard of comparison, but only for particular localized aspects of the overall habitat, and only for a particular target species considered in isolation from its biological community.

A watershed assessment designed to support species conservation would provide information on what has changed since Euro-American settlement, how much it has changed, what the effect of the changes are on the species of interest, and the relative importance of and interactions between different changes. In particular, effective restoration programs require that the causes of impaired conditions be well understood.

As it is currently presented, the draft manual does not provide adequate assurance that the objective can be met. The manual does not explain how the individual modules will be integrated to provide the necessary information other than to indicate that data will be incorporated into a computer-based expert system to construct watershed-based models for identifying limiting factors. The manual does not describe what information will be required by the models or how the models will be tested. The manual also does not indicate how the "desired conditions" or "reference conditions" will be defined and calibrated other than to note that they "will be derived through a multidisciplinary NCWAP effort" (p.61, ph.3) and that the work will be based on "the best available scientific studies on how factors interact to create conditions for anadromous fish on the North Coast" (p.31, ph.6). It might thus be inferred that the method is to be based on a digital variation of the "properly functioning condition" matrix now employed by the National Marine Fisheries Service in some portions of the area. It is worrisome that the only indication of information requirements for the model is provided by Figure 8 (p.33), which is not comprehensible in its present form.

Identification of limiting factors appears to be based solely on descriptions of current conditions within fish-bearing reaches, thereby creating a serious disconnect between current land-use activities and downstream habitat conditions. Because of lag-times in hydrologic and geomorphic response, today's hillslope activities may be leading inexorably to future detrimental habitat changes that may not be evident in the stream for decades. If there is no mechanism to evaluate such influences, there will be no effective way to avoid future damage, design effective restoration programs, or determine whether resource protection programs are effective. Similarly, the manual does not provide a mechanism for addressing the cumulative and potentially synergistic nature of individual factors.

It is unreasonable to expect that the method will provide "a full picture of all the factors affecting coho salmon conditions in the watershed" (p.33, ph.1). Not only are "all the factors" not yet known, but the method itself is simply a new package for an approach that has already been implemented elsewhere and has as yet not been shown to be capable of halting the decline in salmonid populations in the Pacific Northwest.

The "synthesis report" appears to be the forum in which cause-and-effect relationships are to be explored, but there is no description of how the "synthesis" will actually take place. This step would require a chapter of its own to describe the questions to be answered and to explain how those questions will be answered using the data to be provided by the modules. Restoration planning will be ineffective unless the NCWAP procedure provides a strong understanding of the reasons for habitat impairment and the extent of impairment relative to natural conditions.

Overall objective: facilitate implementation of state and federal laws

The primary state and federal laws in question appear to be the Clean Water Act and the California Forest Practice Act. The Clean Water Act requires development of TMDLs for impaired watersheds, and the Forest Practice Act leads to a requirement that cumulative watershed impacts be evaluated for timber harvest plans.

Development of TMDLs requires that the sources and amounts of impairment to specified beneficial uses of water be known, and that the relative importance of different sources of impairment be understood. "Rare, threatened, and endangered species" is one of the specified beneficial uses of water for north coast streams, so information needed to support protection of listed salmonids (which comprise *some* of the rare, threatened, or endangered species in the area) is a very small subset of the information needed to develop TMDLs. Aspects of water quality that are of concern include transport of sediment and chemicals, deposition of sediment, and changes in water temperature, among others. Beneficial uses of water that are of concern on the north coast include those listed in Review Table 2.

A watershed assessment designed to support development of TMDLs would provide the information necessary to evaluate impacts on the list of beneficial uses of water shown in Review Table 2. Such information would include the locations and timing of the uses in and downstream of the watershed; the nature, magnitude, timing, and location of impairments to those uses; and what has changed since Euro-American settlement, how much it has changed, what the effect of the changes are on the beneficial uses, and the relative importance of and interactions between different changes. Methods would need to be presented for assessing the types and magnitudes of impacts being sustained by each of the beneficial uses, and determining how altered conditions within the watershed could have affected the impact mechanisms.

However, the draft manual is not designed to provide information for addressing any of the beneficial water uses listed in Review Table 2 other than salmonids listed under the Endangered Species Act. Some of the information the draft method would provide *might* be useful for addressing other issues, but utility would be fortuitous because there is no provision in the manual for identifying such information needs.

Review Table 2. Beneficial uses of water defined by Water Quality Control Plans

Beneficial use	Description
Municipal and domestic supply	Community or individual supply for drinking and other uses
Agricultural supply	Irrigation, stock watering, forage development, etc.
Industrial service supply	Industrial activities not dependent on water quality
Industrial process supply	Industrial activities dependent on water quality
Groundwater recharge	Replenishment for extraction, water quality maintenance, or control of saltwater intrusion
Freshwater replenishment	Maintenance of surface water quantity or quality
Navigation	Shipping or travel by private, military, or commercial vessels
Hydropower generation	Power generation
Water contact recreation	Swimming, fishing, white-water activities, etc.
Non-contact water recreation	Picnicking, hiking, boating, etc.
Commercial and sport fishing	Collection of fish, shellfish, etc. for consumption or bait
Aquaculture	Includes cultivation of aquatic biota for consumption or bait
Warm freshwater habitat	Preservation or enhancement of warm-water ecosystems
Cold freshwater habitat	Preservation or enhancement of cold-water ecosystems
Inland saline water habitat	Preservation or enhancement of inland saline-water ecosystems
Estuarine habitat	Preservation or enhancement of estuarine ecosystems
Marine habitat	Preservation or enhancement of marine ecosystems
Wildlife habitat	Preservation or enhancement of wildlife ecosystems
Preservation of areas of special biological significance	Includes marine life refuges, ecological reserves, etc.
Rare, threatened, endangered species	Support of habitats used by listed species
Migration of aquatic organisms	Support of temporarily occupied habitats
Spawning, reproduction, and/or early development	Support of high quality habitat for producing fish

Because the California Forest Practice Rules require evaluation of "significant on-site and downstream cumulative effects on beneficial uses of water, as defined and listed in applicable Water Quality Control Plans," an assessment designed to support TMDL development would also provide much of the information necessary to support cumulative impact analysis under the forest practice rules. The forest practice rules also specify that cumulative impact analysis is to consider effects of sediment, water temperature, organic debris, chemical contamination, and peak flow. Consequently, an assessment that is intended to support implementation of the forest practice rules would be expected to provide information on these potential impact mechanisms.

Because it does not adequately address beneficial uses of water, the draft manual also does not provide the information that would facilitate cumulative impact analysis under the forest practice rules. Furthermore, the draft manual indicates that "The framework [for THP cumulative impact analysis] will be designed to be compatible with the level of watershed assessment being conducted by NCWAP" (p.38, ph.4). However, the NCWAP method is being designed to provide an answer to an entirely different "key question"—definition of limiting factors for listed salmonids (p.19, ph.3). If NCWAP is to support THP cumulative impact analysis, then the NCWAP procedure would need to be responsive to the needs of THP cumulative impact analysis, not vice versa. It would be expected that a cumulative impact analysis method would use available information—including NCWAP products—to the extent that it is useful, but not that the method would be designed around a procedure that was itself designed for an entirely different purpose.

Key question and overall critical questions (p. 19)

The "key question" for the entire NCWAP is presented as "What factors are limiting salmonid and macroinvertebrate populations?" Critical questions are then presented which apparently are expected to lead to the answer to the key question. However, the critical questions, although useful individually, will not provide sufficient information to answer the key question. To do so, answers to several other questions would also be necessary: "How do current and likely future watershed conditions and processes compare to those under which the salmonids in question evolved in the watershed?" and "How do conditions in the watershed influence conditions and processes downstream of the watershed?" It is only through answering these questions that the "desired conditions" or "reference conditions" can be defined.

It should be noted that with the "key question" defined as narrowly as it is, the "objectives" of NCWAP to support TMDL development and Forest Practice Rule implementation appear not to have influenced the design of the program. These applications thus appear to be incidental by-products of the process rather than focal objectives.

Critical questions for individual assessment components (Chapter 4)

Answers to these questions, for the most part, would provide very useful information about each watershed, and would go a long way toward addressing each of the overall NCWAP objectives. However, the methods described in the modules in many cases do not appear to be capable of actually answering the questions. For example, the sediment module intends to answer the question, "What are the likely responses of hillsides to potential changes in existing conditions such as runoff, vegetation, and land use?" However, the draft manual provides no direction for evaluating the kinds of hydrologic changes on hillslopes that would influence landslide activity.

In other cases, the critical questions posed for individual assessment components will not provide the information necessary to address the "overall critical questions." As an example, an overall critical question is "What is the spatial and temporal distribution of sediment delivery to streams from landsliding, bank, sheet and rill erosion, and other erosion mechanisms, and what are the relative quantities from each source?" (p.19). The sediment module, however, is then described to consist of "a landslide component and a stream channel component" (p.49). A model for predicting surface erosion apparently is to be selected at some time in the future, but methods for evaluating other erosion processes are not mentioned, and there appears to be no provision whatsoever for construction of the sediment budget described by the overall critical question.

Many of the currently unanswerable critical questions require integrative work if they are to be answered. At the same time, the utility of the manual would be greatly enhanced by incorporation of more information concerning how integration will be achieved. These two problems would be simultaneously

addressed if the methods are rearranged by critical questions. If an outline is provided for how each question will be answered, assurance could be given that the methods provided are indeed adequate for achieving both modular and overall objectives. Otherwise, a list of tantalizing questions, followed only by a section stating, in essence, that landslides will be mapped, suggests to the reader that the decision to map landslides preceded both consideration of why landslides were to be mapped and consideration of what kind of landslide information is necessary and sufficient for answering the overall key question.

III. SPECIFIC COMMENTS

Limiting factor analysis (p.27)

We believe that watershed assessments are best done by iteratively approaching from a conceptual, holistic view, then identifying critical unknowns, and returning to improve and add more detail and quantitative analyses. In this process, top-down and bottom-up approaches can be used interactively to analyze a complex problem. The Limiting Factor Analysis (LFA) is essentially a detailed, mid-level, top-down analysis that starts with stream channel condition and infers the suitability of physical habitat for fish. Despite its modest breadth of watershed processes, LFA seems to dominate the NCWAP process: LFA *is* the initial analysis in the watershed assessment (Figure 4, p.18). A LFA analysis would conceivably integrate into a broader, top-down analysis that relates factors affecting stream channels (e.g., landslides and channelization) to channel condition; it would integrate into a bottom-up analysis that would start with information on fish populations to infer limiting factors of habitat.

The LFA will employ a computer-based decision support system (EMDS). Advantages of such expert systems are that they can force analysts to fully articulate the linkages of a complex system such as a watershed. This can bring out all aspects of the system regardless of the level of understanding or information about them, and thereby lead to discovery of new linkages, identification of gaps in knowledge, and evaluation of uncertainty. This approach does not require sophisticated software, but a computer-based system can facilitate this effort and allow more complex problems to be analyzed. However, the danger is that the EMDS could become standardized for all watershed assessments, and thought in the formulation of a LFA could be replaced by turning the crank on a seemingly sophisticated analysis engine.

In this regard, the proposed LFA seems to lack an historical context. It would be useful to know habitat conditions when fish were plentiful and how fish used the channel network then and now. All watersheds were not designed to produce a uniformly high population of all species of fish. The physiology and life histories of fishes in each major watershed have evolved to some degree to sustain populations under the range and makeup of habitat conditions inherent in each watershed. Therefore, it is unlikely that the linkages and parameters used in an EMDS can be lifted from one watershed to the next.

An initial fish-oriented watershed assessment would put the present fisheries in context with the history of its watershed more comprehensively but less quantitatively than the proposed LFA. In this manner, major changes in the watershed and its fish populations could be coarsely evaluated to paint the general trajectories of present-day conditions. Such a broad view would be unlikely to miss the major factors affecting fish populations. For example, channelization of a complex and expansive lowland system of side channels and estuaries at the turn of the 20th century into to a simple, single-thread channel would stand out as a major hit on salmon productivity. Such a loss of potential productivity could be overlooked if modern habitat were compared with a range of conditions constrained by modern valley-bottom morphologies. An initial watershed assessment would guide further information gathering and analysis, including a more quantitative and systematic LFA. In contrast, relying initially on a detailed, programmatic analysis could miss some of the big picture provided by a broad view of watershed condition and history. It would be best to integrate LFA into an evolving, comprehensive watershed assessment conceived at the outset.

There are several aspects of the EMDS that were not explained: How will different parts of the stream network and its habitat limitations be integrated? How will seasonal changes in habitat and habitat requirements be integrated? How will survival and growth at various life stages be integrated? Most importantly, how is uncertainty to be evaluated and incorporated in the results? How will information on fish populations be used in the LFA and watershed assessment?

Riparian vegetation conditions (p.44)

To be useful for evaluating the extent of environmental change, riparian vegetation conditions need to be assessed relative to naturally occurring conditions. There is no provision for such an assessment in the draft manual. Such information will be important for assessing woody debris conditions and stream temperature changes.

Various temperature models indicate that stream shading has a lesser influence on stream temperatures than does air temperature, and air temperature is strongly influenced by riparian stand conditions. Analysis of shading alone is thus inadequate for assessing potential impacts on stream temperature.

Sediment production and transport: landsliding and channel condition components (p.47)

This module is a top-down analysis of landsliding and channel condition. This is essentially a stand-alone piece because the landslide/channel component is to be started before each watershed assessment. This strongly limits opportunities for interaction with other components of watershed assessments during the critical initial stages. The landslide/channel component begins with detailed mapping of landslides and relates their apparent effects on channel condition, which is also mapped, and finally these effects are related to inferred habitat condition. Plans for data acquisition and packaging in a GIS framework are ambitious. Although this exercise should provide useful information for many watershed assessments in this region, it lacks feedback mechanisms to assure the most relevant information is gathered in the most efficient manner to serve the purpose for which it is intended, a watershed assessment. It assumes that the predominant link between watershed processes and fish habitat is landslides that are large enough to observe on air photos. There are no apparent feedbacks (Figure 1, p.6; Figure 4, p.18) between the watershed assessment and data acquisition. The steps involving DMG's role in watershed assessment show little participation of outside entities in formulating critical questions or otherwise identifying needed information. After a 30-day internal review, the Watershed Assessment team has 15 days to review the DMG report. Nothing is mentioned about DMG obtaining additional needed information that might be identified in this review.

Potentially valuable information for watershed assessments would be provided from this module, including landslide volumes and occurrence, association with geology, topography, and land use, and sediment sizes delivered to channels. In some cases, other information might be useful. This includes the size and volume of large woody debris delivered to channels from landslides; at the minimu m it would be valuable to categorize forest stands that existed on landslides before they occurred, and thereby crudely evaluate their contribution of LWD. Sediment from sources other than mappable landslides (e.g., gullies, roads, and smaller landslides) may be significant, especially in terms of chronic inputs. Other strong influences on channel and habitat condition, such as water diversions, channelization, gravel mining, stream cleaning, and riparian stands, would have to be evaluated in order to understand the influence of landslides on channel condition. Much of this data is difficult and costly to obtain and it would be economical to evaluate its usefulness to the watershed assessment before the data were gathered. If the watershed assessment were driving data acquisition in an iterative top-down-bottom-up approach, the utility of data on landslides and other factors affecting channels could be optimized and tied more directly to the target issues.

Methods to assign causative factors and landslide potential are not clear. Quantitative models based on slope stability, which could be useful for such analyses, are not mentioned. For example, SHALSTAB could provide a general framework to examine landsliding by illuminating the potential for shallow landslides originating from zones of convergent colluvium and runoff. Although not all landslides are the same or originate from similar locations, comparing SHALSTAB results with the occurrence of actual landslides could reveal other causal factors such as deep-seated instabilities and land use.

The relationship between the channel information provided by DMG and that needed for the limiting factor analysis is not clear. Because of limitations of scale, most of the channel information will be obtained from aerial photographs and DEM's. Details on photo interpretation are in Appendix A, which was not available for review. Most aerial photos, especially earlier ones, are too small of scale to observe channel features, and riparian canopies commonly obscure channels. The only changes that can usually be seen between sequential photos are changes in the extent that the riparian canopy covers the channel. Observations are especially limited in low-order channels, which are key links between hillslopes and fish-

bearing channels. Air photo interpretation would miss gullying and extension of channel heads. Nevertheless, air photo interpretation combined with gross topography from DEM's (e.g., reach gradients, presence of valley flats) can be valuable in predicting patterns of sediment routing and channel sensitivity to inputs of watershed products. However, information on habitat condition usually requires a finer scale (e.g., LWD loading, pool frequency and volume, hydraulic variability). Matching channel information available at a basin scale to meaningful assessments of changing habitat condition will be a critical linkage in the watershed assessments. It will require iterative feedbacks between DMG and DFG.

Critical questions on channel condition focus on sediment. They do not address potential sources, actual inputs, transport, and anthropogenic removal of large woody debris. Neither do they address variations in runoff due to climatic events or anthropogenic changes in runoff rates. Data on these watershed products may be forthcoming from another agency, but channel condition cannot be understood without information on the variation of inputs of all watershed products.

The assertion that the landslide/channel module must be the responsibility of a (certified) engineering geologist unnecessarily disqualifies some of the most qualified people to perform this task. Engineering geologists are usually well trained in slope stability but poorly trained in channel processes and mostly ignorant of aquatic ecology. Key participants in a watershed assessment with prominent ecological issues must have an interdisciplinary outlook on physical and biological processes. For this purpose, a geomorphologist, who typically would have a background in geology, hydrology, and fluvial processes, and more likely to be conversant in terrestrial or aquatic ecology, may be best qualified in assuring that landslide and channel information are useful to a watershed assessment. Engineering applications of such information would be most useful for projects of smaller scope and scale.

Sediment production and transport: surface erosion (p.52)

Surface erosion is intended to be evaluated using a model, and the draft manual states that "any erosion models used will be thoroughly examined and, to the extent feasible, ground-validated before being used by NCWAP." This statement is not particularly enlightening—"thorough examination" of a model is meaningless, and there is no indication of how it is to be decided whether testing of a model is "feasible." A model cannot be validly used unless there is assurance that the model is valid for the conditions to which it is being applied. Use of the model is not "feasible" unless it is tested, irrespective of the budgetary or time constraints that might be used to decide that model validation is not "feasible."

Water quantity (p.57)

The overall critical question concerning water quantity (p.19) is not sufficient to satisfy the overall objectives of the program. The issue is not simply whether extractive uses have altered flows. Instead, the influence of land-use activities on the hydrologic regime in and downstream of the watershed must be understood. The critical question in the water quantity module is also not particularly useful because it limits the assessment to conditions "relative to salmonid fish survival."

Additional hydrologic information that would be essential for any kind of "synthesis" would be assessments of the actual extent of the drainage network in each watershed; the extent of ephemeral channels; the extent of overland flow; the periods of flow in various portions of the network; changes in low-flow characteristics; changes in peak-flow characteristics; and changes in runoff. The issue is not simply whether water quantity has changed, but whether the hydrologic regime has been altered or is susceptible to change.

Land use historical analysis (p.63)

Information to be provided by the historical module is critical for completion of each of the other modules because stratification of the landscape for sample site selection would need to be based in part on land-use history if relationships between land-use patterns and environmental conditions are to be recognized. The information would therefore need to be provided before other modules are begun.

It is worrisome that after the list of information to be provided by the historical module is presented in Table 6 (p.64), it is then noted that "it is unlikely that all potential issues listed in Table 6 can be fully addressed within the budgetary limitations of NCWAP" (p.68, ph.3). If the manual has been written without considering the practical limitations on what is feasible, then it provides no real indication of what would actually be provided by an assessment.

The statement that "Unlike the data collection for other aspects of NCWAP, researching, locating and accessing (and in some cases reproducing) the data [for the historical module] will take considerable effort" is very peculiar. It would appear that whoever wrote this module has not read the other modules, and is not aware of the fact that landslides are to be mapped and streams habitat-typed throughout much of northwest California. If each module was written in isolation, how is it expected that the end result will be integrated?

Social and economic assessment (p.68)

Many people in Humboldt County do not live in the same watershed in which they work; and many Humboldt residents work in many different watersheds. Each watershed thus functions as a component of larger socio-economic communities. A socio-economic assessment of the watershed would thus need to consider a larger scale than that of the watershed itself.

Since it's the history that created current conditions, and since trend definition requires more than one data point, the 1990 census data is assuredly not "too dated to be worthwhile to bring into the NCWAP watershed assessments" (p. 69, ph. 8).

Quality assurance (p.70)

It is not true that "data collected with low precision may be useful for screening purposes, but not for answering specific questions" (p.70, ph.6). Some "specific questions" can be answered *only* with data "collected with low precision." The nature of the question determines what data are useful and what level of precision is adequate; data quality cannot be determined without knowing the intended use of the data. Overkill on data precision is counterproductive because it diverts resources from other components of an assessment.

IV. SUGGESTIONS FOR A REVISED APPROACH

Constructing a watershed assessment method is somewhat analogous to constructing an airplane. One approach would be for experts at the various components (wings, fuselage, engines, undercarriage) to work in isolation to invent their best designs and then fit them together to create an airplane. The result might be a jet fighter with pontoons, or one that actually flies only after mammoth budgetary overruns. Another approach would be for the various experts to work together from the outset to design and build the entire plane, starting with the entire framework and modifying each component to mesh with the others. The result might be a plane that is optimized for its intended application and is constructed within the budgetary constraints.

The draft NCWAP guide has elements of both approaches. The latter approach is embodied on p.15,

> *"The need for interdisciplinary cooperation in watershed assessment cannot be overemphasized. In order for the assessment process to consider how anthropogenic and natural processes interact to affect watershed conditions for fisheries and other uses, and to assess their implications for management, NCWAP agencies will need to work closely together at all stages of the assessment process."*

On page 17, the NCWAP process moves quickly to an initial analysis after scoping issues and compiling existing data. Afterward, additional information and analyses are incorporated into an evolving assessment.

However, at closer examination, the former approach to airplane design seems to dominate the NCWAP process. The initial analysis turns out to be entirely the LFA in the framework of a computer program (Figure 4, p.18). The ambitious program by DMG to remap landslides and measure channel condition is scheduled to be mostly completed *before* a watershed assessment begins and actual data needs are known. Archival research of watershed history, which would be invaluable at early stages on a watershed assessment even if incomplete, is depicted as a time-consuming process culminating in GIS layers, presumably available late in the assessment. Little is said of the makeup, qualifications, or functions of the assessment team.

The pitfalls of airplane design #1 could be easily avoided by beginning a watershed assessment with a preliminary evaluation of issues and information needs in the watershed. In this manner, the supporting information and analyses would be assured to be of maximum usefulness to the assessment, and

the final product would be an assessment that flies. The watershed assessment should drive information collection and analysis according to airplane design #2, not *vice versa*.

A revised assessment procedure that would incorporate this approach might look like the following:

Step 1. Initiate the assessments watershed by watershed. This begins by identifying key issues and key questions specific to the watershed being assessed using readily available information. The goal of an initial assessment is to identify the type and detail of information needed to answer the key questions. This can be accomplished by formulating a train of logic that links questions to issues. Information needs can then be quickly passed along to the supporting agencies so that they can immediately begin to collect and assemble needed information. Likewise, key players in the assessment process can be identified and recruited. The assessment is now underway in full scope, although issues, questions, and analyses have only been framed. A time limit should be set for this phase (say, one week). The State could decide to initiate assessments in all watersheds in the first year or over a longer period in the order of the current schedule. In either case, we anticipate that the supporting agencies would be as fully engaged in data gathering as currently planned. The difference would be that, after initiation of an assessment, information gathering would proceed hand-in-hand with the assessment and be tailored to its needs.

Step 2. Proceed with information gathering and further analyses. This is an iterative process whereby new information is fed to answer key questions, new questions are raised and old ones refined, and additional information is sought. Some of these cycles of questions and information gathering will take longer than others, and the final scope and intensity of data collection (e.g., landslide mapping) in a given watershed may or may not look like that described in the draft NCWAP manual. Certainly, reconstructions of watershed history will be valuable for every assessment and could begin at the outset of each. During this step, goals should be revisited and criteria for completion should be clearly defined given the available time and resources.

Step 3. Complete the assessment. Put simply, a watershed assessment is complete when the criteria for completion are met. The writing phase is an important analytical step, for it reveals new links and gaps in information. The first solid draft should be sent out for review, and the reviewers given adequate time for the review. The review should then be explicitly responded to, and adequate time should be set aside for a substantial revision, including incorporation of new information or analysis.

Watershed assessment or analysis is new to the state of California, and such analyses by the Federal government, private industry, and agencies of other states have had mixed results at best. It is appropriate for California to learn from these efforts and create procedures that fit the needs of the State.

Given the challenges of the ambitious set of objectives of NCWAP, it would be prudent to initiate the program with one or more carefully conducted and documented prototype assessments to serve as testing grounds for potential assessment methods and, if all goes well, as models for later assessments. These first examples should be scrutinized to reveal the right ways, as well as the wrong ways, to conduct watershed assessments. The model assessments would take the following steps:

- An exceptionally qualified assessment team would be selected based on their knowledge of a broad range of disciplines and demonstrated ability to work in an interdisciplinary team.
- The team would be given the NCWAP guidelines, but also a mandate for flexibility in procedure.
- The team would be supported by agencies that would provide information and analysis of some of the components of the assessment at the request of the team.
- The assessment process would be carefully documented.
- The final assessment would receive peer review.
- A final report would be prepared, including the watershed assessment, a description of the processes employed and their successes and failures, and recommendations for revision of NCWAP guidelines.

We believe that the whole of a well-integrated watershed assessment is more valuable than its parts; a watershed assessment is more than a body of information in a geographic context. A watershed assessment at any stage captures progress in understanding the watershed, given the available information, and enables further progress to build as more information is fed into evolving iterations of the assessment.

If no more is done than accurately identifying issues and posing key questions regarding those issues in each watershed, then a valuable service has already been performed. A watershed assessment greatly enhances the value of the information gathered by the agencies and highlights their services. We expect that these assessments, if designed to develop a level of understanding applicable to the variety of applications already evident, will have enduring value in California's dynamic social, political, and environmental arenas.

June 1, 2001

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Dear Rick:

Enclosed are "marked up" copies of the draft NCWAP Watershed Assessment Methods Manual and the DOC/DMG appendix. I had more substantive comments regarding the DOC/DMG appendix than the larger document, although you will find comments in the margins in both documents. Following are a few summary comments.

1. The documents were generally well-organized and clearly written. I felt the introductory and overview material did a good job of outlining a relatively complex set of inter-related topics and State programs.
2. The objectives of the NCWAP were generally well-defined, including limitations that attempt to define what NCWAP is not intended to accomplish.
3. On page 14 in the last paragraph, the history of the Washington DNR process is misrepresented with respect to Level I vs. Level II analyses. Few, if any, Level I analyses were conducted because it was generally agreed that they produced insufficient data and insights to generate meaningful assessments. Almost all DNR Watershed Analyses were conducted at Level II, primarily by consulting teams hired by commercial forest landowners.
4. My biggest concern is that even given the generally well-defined limits of the NCWAP, it may be difficult to deliver a credible, data-driven Limiting Factors Analysis. Based on my experience performing the Washington DNR process at Level II in Washington, Montana and California, I have doubts whether the extent of detailed data that will be generated by NCWAP will be sufficient for LFA. Even given DNR Level II data, there would be substantial uncertainties that would affect LFA. Consequently, I wonder whether NCWAP LFA will be much better than what might be developed based on general principles of watershed processes, fish habitat, and regional management and geographic characteristics. In any event, the proposed use of the EMDS system (p.30) will help clarify assumptions and limitations of the LFA. Based on my limited knowledge of EMDS, I believe it will be an invaluable tool over the long-term in watershed assessment, monitoring and management.
5. I believe that NCWAP will produce a wide variety of useful data and interpretation regarding watersheds. Although the manual objectives attempt to distinguish clearly between "assessment" and "analysis" (p.14), there is some inherent contradiction between acknowledged limitations and advertised products (e.g. the LFA as per #4). One scenario of concern is that NCWAP assessments will be considered by some to be the final, authoritative determination of conditions and land use impacts, setting up conflicts between the envisioned subsequent and more detailed analyses conducted by project proponents and landowners (p.10, last paragraph) that may reach different conclusions based on more detailed data and analyses. This is probably unavoidable, nor does it suggest that NCWAP will not produce a useful starting point for subsequent analyses. Furthermore, the DOC/DMG appendix suggests that some sub-basins may be investigated at a more detailed level, and this may well ameliorate the potential problem. Still, when there is incomplete data and uncertainty, their will likely be good reason to err

on the side of higher landscape and stream sensitivity in order to reduce risks of habitat damage. This will likely place a greater burden of proof on landowners in development of projects in a manner that is environmentally benign. Fortunately, NCWAP will help to provide for an appropriate scope of analysis with substantial watershed-scale data to allow for a meaningful project-level cumulative watershed effects (CWE) analysis. Perhaps the conceptual model will become something like water rights adjudication, where all landowners will be motivated to join in a sufficiently detailed assessment to determine allowable projects in a CWE context.

6. The DFG methods for LWD inventory in channel are reasonable, but the protocol proposed also includes an extensive riparian stand inventory that appears to be more detailed than necessary for stated purposes. Simpler stand classification schemes such as CWHR would be sufficient to assess shade and LWD recruitment functions. The proposed stand inventory could be of great value in a detailed study or modeling effort regarding LWD recruitment processes; if such work is contemplated, my reservations are unfounded.
7. The DOC/DMG appendix addresses subjects with which I have the greatest experience. There will be significant overlap between FG habitat assessments and DMG channel assessments; maximum coordination is critical. Channel assessment methodology is necessarily broad and flexible. Even so, I believe the DMG methods and objectives could be made somewhat more specific. Although much is implied regarding underlying principles by reference to a set of appendices, there isn't much of a declaration regarding controlling geomorphic principles that might be applied to answer critical questions. Much will depend on the skill and experience of the geologists performing the channel assessment.
8. It remains unclear to me whether DOC/DMG intends to analyze as many as 10 sets of aerial photographs for each watershed or whether there will be a selection of fewer sets (the latter is implied, but not clearly stated). It also remains unclear whether DOC/DMG intends to provide quantitative estimates of landslide volumes and sediment delivery volumes to streams. In my experience, even given inevitable estimation and uncertainty, a quantitative sediment input budget is the single most valuable tool in addressing a major element of CWE's: erosion and sedimentation issues. I strongly advocate that DOC/DMG landslide inventories should be conducted to provide quantitative sediment input budgets (my concerns of #5 notwithstanding).

Please feel free to contact me if I can clarify any of my comments or be of further service in helping this valuable State program.

Respectfully,

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May 29, 2001

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Re: NCWAP Watershed Assessment Methods Manual

Dear Rick:

Enclosed is the annotated Methods Manual. I've made a variety of comments on the draft. I have tried to be overly critical, and hope that the authors don't take my comments personally. Some of the methods clearly fall outside my field of expertise (I'm a geologist, not a biologist, ecologist, etc.). Regardless, I have tried to comment on aspects of the Manual that deal with goals, techniques etc. Take them for what they're worth. My comments regarding Chapter 3 in particular should be viewed as those of a person without expertise in some of the techniques and computer programs mentioned in this chapter.

Overall, the manual is a good first attempt to create a framework within which one can assess the conditions and the health of watersheds. It is obviously a formidable task to try and write an all-encompassing manual on this subject. However, I have reservations regarding the collection, analysis, quality control, and validity of much of the data; and even greater reservations regarding the use of a computer program to assess the state of the watershed. The limiting factors analysis portion of the manual is not well written and it is not at all clear how this system works. This section needs to be rewritten. I'm also concerned that, as with all computer models, the answer you get will be the one that the person who prepared the program and weighed the data wants.

There is much room in such programs for subjective evaluations to creep in as objective evaluations, and for blatant manipulation of the end product. I see this as a major problem with the manual, and I think the public will do likewise. To some extent the manual itself and the entire process of watershed evaluation must be viewed a honest and dispassionate by the public, or at least the majority. To achieve this goal it is essential that the manual clearly spell out how conditions will be described, weighted and analyzed. I think it is unwise to say "We're gonna stuff all this data into the computer and it will make the decision - trust us."

The comments below refer to individual chapters.

Chapter 1. Introduction

I'm somewhat concerned about the goals. When I break them down they seem to be as follows:

1) Provide a baseline of data. *This is appropriate. You are trying to collect and analyze data on watersheds.*
2) Evaluate the effectiveness of resource protection programs. *Also appropriate. No sense spending money if it isn't doing any good.*
3) Guide watershed restoration, target grant dollars, assist various groups to develop projects. *I presume that we are referring to salmon protection projects.*

4) Guide everybody to "protect the best". *It might be useful to define "protect the best". It sounds very subjective to me.*
5) Help everyone implement laws that require specific assessments. *Most of the public will read this sentence and interpret* ***"implement"*** *as* ***"enforce."*** *Many landowners will read this as an onerous mandate to conduct costly scientific studies before they use their land.*

In addition, the authors should realize that many individuals will view this manual as the handbook for stopping all development, logging, mining, resource usage, grazing and development on private land. A handbook written by environmentalists for salmon populations.

The first chapter emphasizes complex assessments across scientific disciplines. The emphasis is on what I view as secondary goals, those that will be developed by interpreting the basic scientific data with an avowed purpose. It's not that the goals are themselves bad, only that they're derivative or secondary in that they will be based on the basic data. The primary goals are (or should be) the collection of good relevant scientific data, its compilation, analysis, evaluation and synthesis. Once that has been accomplished for a large number of watersheds you can start to interpret the data and then go on to the secondary goals. Since it is likely that during the initial data collection you will modify and change some of the techniques (drop some, modify some, and add some) it will be difficult to achieve the secondary interpretive goals until most of the data has been collected.

Using a 5 day work week over seven years the project will have to evaluate approximately 6 square miles per day for the entire project. This is obviously a very ambitious project. I am also concerned that many of the goals may be simply not be achievable in the time span proposed.

Other thoughts: Everybody seems to like electronic publishing (except me). It does away with hard copies, mailing materials, etc. Because many of your products will be in map form I suggest that hard copies be made available for the luddites like me. Not everyone that needs this data will be computer literate enough to download maps and other complex graphics.

Chapter 2.

This is an extremely poorly written chapter. Not only is it bureaucratic but damn near unintelligible. The distinction between *assessment* and *analysis* is vague at best, and the examples are inappropriate. The manual does not make a clear distinction between the two. On page 15 are sentences that defy interpretation. One has four prepositional phrases simply strung together at the end of a sentence. This entire chapter appears to be an attempt at obfuscation. The diagrams and charts are hardly any better - word lists in boxes. I've commented on many poorly written sentences, but I haven't commented on all of them. The 6 steps on page 17 are reasonable, but there are some comments within them that require further definition or explanation. The key questions on page 19 are reasonable, but it seems there must be other relevant questions for the study to consider. Many of the questions are poorly worded and vague. The entire chapter needs to be reviewed and rewritten.

From page 20 on the writing improves considerably. Most of my comments are relatively minor on the rest of the chapter. Under **Public Review Process;** I suggest that you make the manual available for review more than 1-2 weeks before the public meeting. I suggest at least a month. If you make the it only available for a week before the review many people will view it as an attempt to slide the manual through without proper review. A week is not a lot of time to get the manual,

read it think about it and then be prepared to write a review of a 100 + page manual. If nothing else a one week review period will look bad and piss off a lot of people.

On page 23 an important concept - **the assessment methods are expected to evolve over time**. You should emphasis this more. Most people will simply breeze past it. You need the public to understand that the manual is not the gospel. It, without question, will need to be modified through time. The public should be aware of this, should be notified when it happens, and be allowed to comment on the changes.

Chapter 3.

Again, this is a poorly written chapter which contains many poorly written sentences of questionable meaning. I have numerous questions about both the "products" and the "analytical approach"

First - the synthesis report appears to have a marginal value at best since it does not offer site-specific project recommendations. Yet on page 27 it suggests making some type of semi-recommendations regarding a variety of factors.

Second - The limiting factors analysis section is completely unclear. The definition on limiting factor (paragraph 4, p. 27) would seem to limit any and all uses of the watersheds. It is an exceedingly broad definition, and can be interpreted very radically. What is completely unclear is how a decision is triggered regarding the component's condition in the stream. I think it would be essential to define exactly what comprises the desired in-stream conditions. I realize that may not be possible at this time but you should provide a better example of how data will be interpreted and used. Also for each major in-stream condition, how far can it fall out of the desired range before it becomes a limiting factor. Also what are the temporal constraints? Conditions are never optimal for a whole year. How will time limits be determined? The lack of detail in this section is gaping loophole that could allow almost any subjective decision to control what is the limiting factor. This one can play both ways - depends which group of politicians is in power. On page 29 there are several potentially important ideas - particularly the last portion of paragraph #3.

LFA

Again, a very poorly written section that does not address the important issue of how these decisions are made. *"extremely sophisticated modeling"* - always worries me, since only one person knows if the model is valid. Lots of room for mischief. The issues addressed in the last paragraph on page 29 are very subjective and are impossible to quantify in any meaningful sense. The last sentence on the page which ends on page 30 is meaningless.

Pages 31 through 35 are a mishmash of bad ideas that are poorly explained. Many of the sentences and ideas expressed in this section would make George Orwell proud. He could have used this section as an example in his famous essay "Politics and the English Language."

Take for example; **"It helps scientists to build graphical knowledge base networks that specify how each relevant environmental factor is incorporated into an overall stream or watershed assessment."** A nice statement, but what does it mean, and even better, how does it do this? We both know how it's done. Someone decides subjectively how to weigh different factors, and then the program does what it is told to do. The program does not think. It only can do what it is told to do. I could pick out another dozen or so sentences at random. They all have the same

buzz words, *"... will be built using the best available scientific studies... " "Real data are then used to evaluate the "truth"... "* Are there unreal data? *"Truth Value"* (would Guess Value be a better term?).

The diagrams and figures are generally poor and add nothing to the manual. Figure 7 serves no purpose, while Figure 8 needs additional explanation. For example; are the lines that limit the acceptable gravel content or percentage always straight? Using the figure and the text on page 34 it appears that a 5% increase in gravel from 70 -75 % means that the computer cannot evaluate the truth of the original proposition regardless of what it was. Yet a 10% increase to 80% means it is highly unfavorable. Most of the time you will not be able to accurately determine the percentage of gravel in the stream to within 5% without detailed sieve analysis, and then it will depend upon how you sample the stream bed. The entire intent of the computer program is not clear. This is largely because the manual does not say how the stream condition values will be weighed.

Does it take only one stream condition out of the envelope of "goodness" to refute the good condition proposition? If so, then the entire computer program is meaningless, since all of the factors will have had to be assessed by an individual to begin with, prior to entering them into the computer. I've made a variety of comments on the text - please refer to these for more of my skepticism regarding this entire venture. I'm guessing that regardless of how you put this system together you may end up in court, unless you can come up with a better explanation of how these limiting factors will be determined and how they will be weighted. The last paragraph on page 35 seems a bit optimistic. It sounds like a commercial or a sales pitch. Most people are not going to be able to use these programs effectively.

Page 35: The sentence **"Those that incorporate NCWAP findings may have a greater chance of obtaining funding."** Should be stricken or reconsidered since it sounds like a threat. This reads a lot like: "You take our data and use it if you ever want to get funding. If not - screw you."

In summation, this chapter tends to hide, confuse, and obfuscate more than it reveals and explains. I suggest that someone rewrite this chapter and try to avoid the double speak. Explain how the system works and how the decisions are made in the weighting of data and the analysis of the results. On one hand the entire LFA appears to be redundant and inappropriate. Either a factor limits the salmon population or it doesn't, and on occasion the interaction between several factors will limit salmon populations. Most of this will probably be obvious once the data are collected. I personally doubt that the computer analysis will provide anything other than a method for obtaining the answer one wants, regardless of the data available. I've seen it happen before.

The chapter reveals that there is an unlimited potential for the manipulation and doctoring of data sets. It will mostly be done during data entry and by computer manipulation. The KRIS computer available data for public use will only perpetuate the decisions made during data entry and the decisions made by a computer.

Chapter 4

Although some poor writing is also present in this chapter, it does a better job on defining and discussing data collection and analysis. However, the discussion on **Approach** contains numerous problems and what appear to be some glaring contradictions. From my standpoint the approach is contradictory. The manual suggests collecting a variety of data on streams, including: **"perennial vs. intermittent using bed gradient and channel confinement"**. This will be done using 10 meter DEMs generated from 1:24,000 topo quads. Based on years of working with air

photos and USGS topos, and extensive field mapping in heavily forested terrain, I can assure you that the USGS maps are approximations of the topography, the stream gradients and the channel pattern. In the Forest of Nisene Marks in Santa Cruz County small ridges are entirely missing as are small drainages - obscured by trees. The manual notes that the initial classification will be refined by using air photos and limited field checks. It will help, but not solve the problem. The classification problems are also discussed on page 43 where I point out that a gradient class of <1% on a map with a forty foot contour interval will have contours greater than 4000 feet apart. The classification technique will miss many, smaller reaches; it will miss most, if not all, pools; and there will be no indication where the drops are. If the people doing the work "get lucky" they will have an opportunity to use the "new; USGS metric maps where the distances between contours will be even greater and, and the corresponding classification will be even more inaccurate.

Under **Questions and Issues** (p. 41):

1. The introductory statement will probably be impossible to achieve *"... identify stream reaches that are expected to behave in a similar way..."* The classification system is far to coarse.
2. Late Pleistocene - Holocene sea-level changes have drastically affected the shape, sedimentation, gradient, channel form etc. of the lower portions of large stream valleys that flow into the ocean. Sea-level has risen approximately 350 to perhaps 400 feet in the past 13,000 to 17,000 years (depends upon whose sea-level curve you believe). This has drastically affected almost all major stream valleys along the Pacific coast. This needs to be addressed in the manual.

Page 42.

Generally OK, but once again the process of data collection will not provide detailed information on the streams. At the end of the fourth paragraph, the last sentence suggests that the study will aggregate the data anyway, to make decisions for planning watersheds and entire river basins. If that is true, why bother with the data collection at all? Just use topo maps and be done with it.

Data Sources and Gaps

Very rough data will result in a very rough analysis. However, where are the gaps? None seem to be identified in this exceedingly short discussion,

Data Collection

In my opinion this a poor scheme, for reasons that I have already discussed. To put it simply, the use of topo maps and DEMs will allow only the coarsest of data to be collected - and a lot of that will be incorrect. Both the channel confinement and the channel typing techniques are exceedingly poor. Differences will largely be due to minor variations in gradient - most of which in forested terrain will be incorrect. The gradient classes are interesting. It is probable that many areas will simply be in the wrong gradient class. This is a real weak point in this entire plan. I don't think that the project can afford to draw conclusions regarding stream health on data that will turn out to be largely incorrect.

page 47

Paragraph 2 is not a realistic goal. I believe that the proposed system will not be able to provide the information you need.

Sediment production and Transport

The initial discussion of stream systems is, in my opinion, a bit overly simplistic. All rivers and streams have episodes during which there is either too much or too little sediment. It's all part of a broad spectrum of possible events in the channel. Large catastrophic storms do most of the work in a stream. Average flows and sediment loads are statistical aberrations. They are not "normal" in any sense they are simply averages. Sediment load in streams will vary widely on a yearly basis.

Pages 48-52.

This discussion of slope processes is one of the best in the manual. It is inclusive and covers all of the points quite well. I have no major comments on this material.

Water Quality and **Water Quantity, Fish Habitat and Land Use** (pp. 52-68)

No major comments. The techniques are generally reasonable and the limitations of the data that will be generated are identified.

Remainder of Report

The comments in the margins discuss some problems with the social and economic assessments, and with the Quality and Assurance program. My main comments are:

1. I think you will find it impossible to quantify many of the social and historical issues and/or conditions. Even if you do the quantification will be highly subjective.
2. The Q & A program will also be highly subjective. All data will be scrutinized and passed through a series of subjective evaluations along with a few objective evaluations. As I've mentioned over and over the manual describes a process that is highly subjective. Despite all of the efforts of the authors, the evaluations will be largely subjective, particularly because of the data base that will be used - i.e. topo maps and DEMs made from topo maps.
3. The quality of the data collected will be directly proportional to the skill, education, diligence and impartiality of the geologist, biologist, forester, etc. collecting the data. I've seen lots of "good looking" data that was faked.- some of it by academics.
4. If people working in this program have an ax to grind - regardless of their political and social views - they can bias many of the data sets and analysis.

5. GIS data, from my limited experience, has many of the same problems of topo maps, DEMs and orthophoto quads. Sometimes they don't register well with each other.
6. Emphasize to the public that the products of this project are "PRELIMINARY" or VERSION #1. It reduces the value of the material in the eyes of the users and provides lots of room to operate, but it is essential to advertise it as not being the "last word"

Appendices

I've made a few minor comments - nothing of consequence.

Overall Evaluation

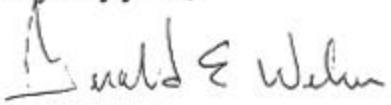
As I mentioned earlier, this is an ambitious program, that will be hard to finish in 7 years. My main concerns can be boiled down to the following:

1. The proposed data base - USGS topo quads. I don't think that they will provide the data needed to make reasonable, observations and analysis of conditions of the stream, much less act as the basis for a reasonable interpretation of stream helath. You need more field data and you need to concentrate on shorter stream reaches if you are to get meaningful data on channel characteristics and gradient.. Therefore I view the data collection program as not adequate.
2. The use of the computer in LFA is questionable at best. I really don't care what system is used - it's a computer making a decision using someone's interpretation of the data. Too much room for mischief.
3. The LFA technique is not adequately described or explained in this manual.
4. Chapters 2 and 3 are poorly written, unclear and contain numerous conceptual problems. They need to be rewritten.
5. Emphasize that the primary goals are collection of data and classification of stream and watershed characteristics. Secondary goals are the interpretation of these data into an analysis of stream "health."
6. Lengthen the review periods.
7. It is clear that many of the decisions made during the interpretation of the basic data will be subjective in nature. The bases for making decision should be clearly spelled out in the manual.

I hope these comments are of some use. I would be interested in how the manual is viewed by other reviewers, and also how the second draft reads.

If you, or anyone else, wish to discuss some of the comments further please call me.

Very truly yours,



Gerald E. Weber